

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 1

1. (Twice Amended) A method for modifying a voxel-based virtual object in a haptic virtual environment, comprising:

determining a virtual tool comprising a plurality of discrete points for use by the user in the haptic virtual environment;

selecting a modification mode [other than a surface deformation for the virtual tool] that modifies a voxel value representative of the voxel-based virtual object;

sensing a location of a user in real space;

determining locations of the plurality of discrete points of the virtual tool relative to a location of the voxel-based virtual object;

calculating an interaction force between the virtual tool and the voxel-based virtual object based on the locations of the plurality of discrete points of the virtual tool and the location of the voxel-based virtual object;

producing a modified voxel-based virtual object by modifying the virtual object based on the modification mode, the locations of the plurality of discrete points of the virtual tool, and the location of the voxel-based virtual object; and

outputting the modified voxel-based virtual object.

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Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 2

2. (Amended) The method of claim 1, further comprising the steps of
- determining a virtual surface for the voxel-based virtual object; and
 - determining a position and an orientation of the virtual tool by determining the locations of the plurality of discrete points relative to the virtual surface of the voxel-based virtual object.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 3

3. (Amended) The method of claim 2, wherein the step of determining the virtual surface comprises determining a virtual isosurface for the voxel-based virtual object.



Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 4

4. (Amended) The method of claim 1, wherein the voxel-based virtual object is a volumetric representation.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 6

6. (Twice Amended) The method of claim 1, wherein the step of selecting a modification mode [for the virtual tool] comprises selecting at least one of a material removal mode, a material addition mode, a smoothing mode, a mirroring mode, and a 3-D sketch mode.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 9

9. (Amended) The method of claim 1, further comprising the step of exporting the modified voxel-based virtual object.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 10

10. (Twice Amended) A system for modifying a voxel-based virtual object by a user in a haptic virtual environment, the system comprising:

a virtual tool comprising a plurality of discrete points for use by the user in the haptic virtual environment, wherein the user selects a modification mode [for the virtual tool other than a surface deformation] that modifies a voxel value representative of the voxel-based virtual object;

a haptic interface device, wherein the haptic interface device senses a location of the user in real space; and

a modeling application in communication with the haptic interface device, the voxel-based virtual object, and the virtual tool, wherein the modeling application determines locations of the plurality of discrete points of the virtual tool relative to a location of the voxel-based virtual object; calculates an interaction force between the virtual tool and the voxel-based virtual object based on the locations of the plurality of discrete points of the virtual tool and the location of the voxel-based virtual object; produces a modified voxel-based virtual object by modifying the voxel-based virtual object based on the modification mode[;], the locations of the plurality of discrete points of the virtual tool, and the location of the voxel-based virtual object; and outputs the modified voxel-based virtual object.

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Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 11

11. (Amended) The system of claim 10, further comprising

the voxel-based virtual object comprising a virtual surface; and

the virtual tool comprising a position and an orientation, wherein the modeling application determines the position of the virtual tool and the orientation of the virtual tool by determining the locations of the plurality of discrete points relative to the virtual surface of the voxel-based virtual object.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 12

12. (Amended) The system of claim 11, wherein the virtual surface of the voxel-based virtual object is a virtual isosurface.

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 13

13. (Amended) The system of claim 10, wherein the voxel-based virtual object is a volumetric representation.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 18

18. (Amended) The system of claim 10, wherein the modeling application exports the modified voxel-based virtual object.



Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 24

24. (Twice Amended) The method of claim 19, further comprising the steps of selecting a modification mode [for the virtual tool] that modifies a voxel value representative of the voxel-based virtual object, and modifying the voxel-based virtual object in response to the modification mode and the position of the virtual tool.

B

Applicant: Shih et al.
U.S. Serial No. 09/347,637
Filed: July 6, 1999

Marked-up Copy of Amended Claim 32

32. (Twice Amended) The system of claim 27, further comprising a modification mode [for the virtual tool selected by the user] that modifies a voxel value representative of the voxel-based virtual object, and the modeling application modifies the voxel-based virtual object in response to the modification mode and the position of the virtual tool.

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